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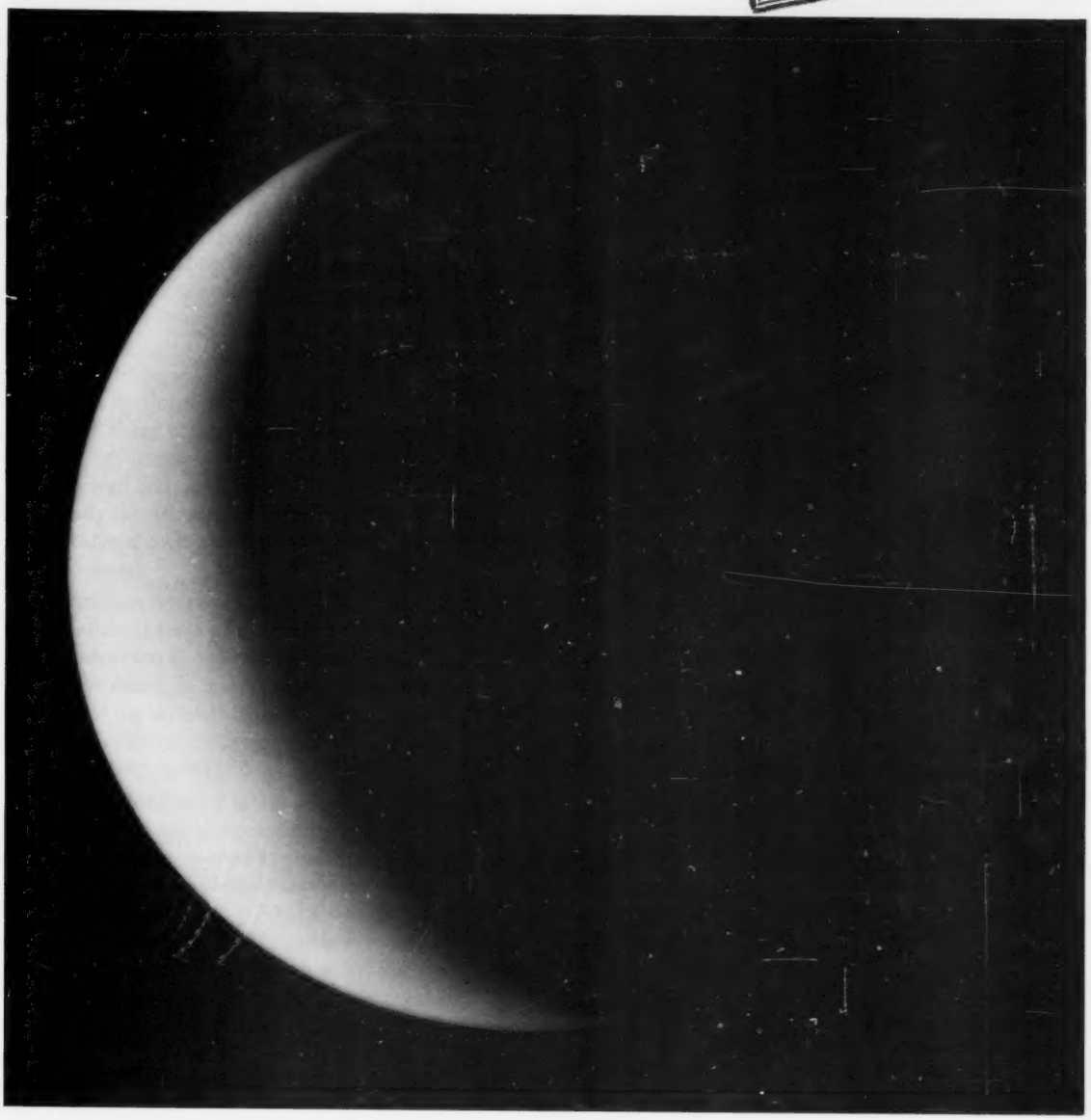

Cover

Pioneer Venus Scoop—The first picture returned by Pioneer Venus after the spacecraft began its eight-month-long orbit. Taken during the early morning of the Venus day, picture shows that the planet's surface is entirely blocked from view by a thick haze of uniform brightness. The best photographs of the planet are expected in mid-January when the disk of the planet will be fully illuminated.

Apologies are extended to the Lewis Research Center for misidentifying the home base of the "I–R 100" prize winners as Ames instead of Lewis (page 19, November Activities).

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Second HEAO in Orbit

NASA launched its second High Energy Astronomy Observatory Nov. 13, continuing a three-mission program to study some of the most intriguing mysteries of the universe—pulsars, quasars, exploding galaxies and black holes in space. HEAO 2 was sent into Earth orbit atop an Atlas Centaur rocket from the Kennedy Space Center.

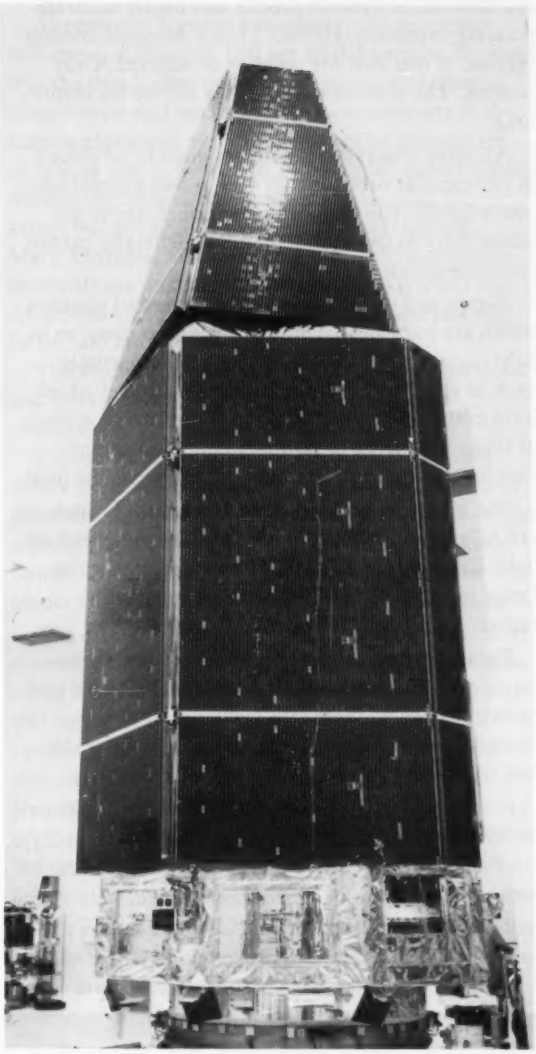
Carrying a focusing X-ray telescope and a variety of sensitive instruments, HEAO 2 will maneuver and point for long periods of time at selected X-ray sources already identified by HEAO 1. HEAO 1 was launched last year to conduct a general X-ray sky survey. The next in the series, HEAO 3, will be launched in 1979 to collect celestial gamma ray and cosmic ray data.

High-energy rays such as these cannot be studied through ground-based telescopes because of the obscuring effects of our atmosphere. The rays first were observed by instruments on sounding rockets and balloons, and by small satellites which did not, however, have the instrumentation capabilities required for high data resolution and sensitivity. These capabilities are now available in the HEAO satellite.

The "pictures" returned by HEAO 2 will be the first spacecraft-generated X-ray images of wide objects other than the Sun. (The Apollo Telescope Mount, which was part of Skylab, produced images of the Sun in the X-ray region.) HEAO 2 images acquired by the X-ray telescope will be converted to telemetry, then received and taped by ground stations. Eventually this telemetry will be reconstructed as photographs showing size, structure and detail of the objects viewed.

Information returned by HEAO may provide clues to the nature of some of the "newest" and most mysterious celestial objects in the universe. This knowledge could, in turn, lead to a better understanding of the invisible high-energy universe and to new theories about energy production and high-density nuclear matter.

The first observatory is still operational, surveying and mapping X-ray sources throughout the celestial sphere and also measuring the low-energy gamma ray flux. The spacecraft can survey the entire sky in six months. Although HEAO 1 was designed for only a six-month lifetime, the quality of the data returned was so excellent that an extension was authorized. The spacecraft is expected to remain active until it reenters Earth's atmosphere or depletes



the onboard control gas supply, probably in early or mid-1979. Besides mapping the X-ray sky, the highly successful satellite has performed more than 300 pointing operations.

HEAO 1 and HEAO 3 are designated as scanning (or mapping) missions. They rotate slowly end-over-end, with one revolution about every 30 minutes. Each uses a gas thrust reaction control system to maintain proper sky-scanning orientation so the solar arrays face the Sun at all times to provide electrical power for the satellite.

HEAO 2, termed a celestial point mission, is different. Because it must point to specific stars or points in the sky, reaction wheels that control torque

are installed to provide precise and highly accurate pointing capability. HEAO 2 has a designed mission lifetime of one year for pointing at selected X-ray sources. The mission of HEAO–3 will be six months long.

All three observatories are designed to be placed in low circular orbits, about 455 to 540 kilometers above Earth. The altitude is far enough above the atmosphere to detect radiation that generally cannot reach the ground.

X-rays and gamma rays are composed of photons, which are particles having energy but no mass, as in light rays. Cosmic rays are composed of particles such as electrons, protons and atomic nuclei which have both mass and energy. An X-ray has thousands of times the energy of ordinary light, and gamma rays have millions of times the energy of visible light.

The high-energy X-rays and gamma rays which the HEAOs study travel through space at the speed of light. They are forms of electromagnetic radiation. Other forms include ultraviolet and infrared radiation.

For many years researchers have studied these forms of radiation and their energy mechanisms and have transformed them into many practical uses, including electrical applications, holography, radio and television, radar and infrared photography.

In high-energy astronomy, interest is in the extreme short-length waves known as X-rays and gamma rays. On Earth these rays are produced by natural radioactive minerals and manmade means from well-understood physical processes. They are used routinely in physics, chemistry, engineering, medicine and other scientific fields. Much is to be learned, however, about the way in which X-rays and gamma rays are produced in deep space—in some cases, with incredible intensity.

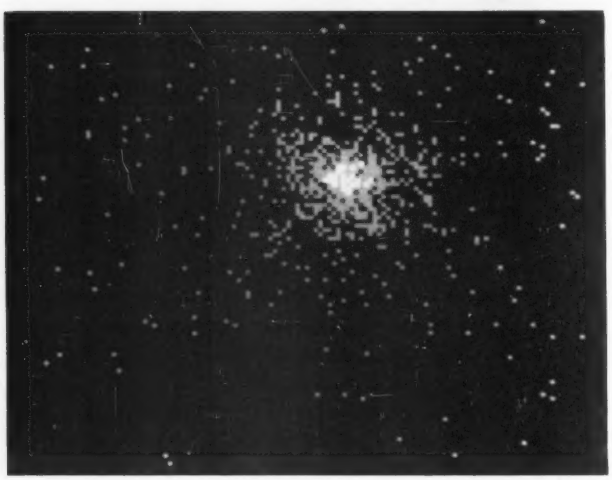
Radiation data collected by the HEAO observatories, after being reduced and analyzed, are expected to lead to a better understanding of how the extremely high energies are generated in space, how basic elements are formed, how the universe evolved and the extreme physical processes evident within the universe.

HEAO is managed for NASA's Office of Space Science by the Marshall Space Flight Center. Program manager is Richard E. Halpern and the program scientist is Dr. Albert G. Opp, both at NASA headquarters. Dr. Fred A. Speer is the project manager at the Marshall center. Spacecraft prime contractor is TRW of Redondo Beach, Calif. The X-ray telescope was designed by Smithsonian Astrophysical Observatory and developed by American Science and Engineering, both of Cambridge, Mass.

The Kennedy Space Center manages the launch operations, including prelaunch checkout, launch and flight through observatory separation in orbit. NASA's Lewis Research Center, Cleveland, Ohio, manages launch vehicle procurement and related activities for the HEAO program.

Control of the in-orbit HEAO observatories is under the direction of the Marshall center in conjunction with TRW flight control engineers operating from facilities at the Goddard Space Flight Center.

The three-mission HEAO program costs about $248 millon, of which some $87 million represents the cost of HEAO 2.



First Look at an Astral Phenomenon—Soon after launch the first picture ever taken of an X-ray star was transmitted from the satellite, HEAO, to the Goddard control center in November. The star is Cygnus X–1, a binary system located about 6,000 light years from Earth. Scientists speculate that the feature contains a black hole—a massive star that has collapsed in on itself to a density so great that not even light can escape.

Dramatic Encounter with Venus

The most extensive study ever made of Venus began in December when Pioneer Venus 1 and 2 arrived at the planet. Pioneer Venus 1 swung into orbit around the cloud-covered planet on Dec. 4, to take pictures and make measurements for one Venusian year (225 Earth days) or more. On Dec. 9, the four probes and transporter bus that make up Pioneer Venus 2 plunged into the Venusian clouds at widely separated points for detailed measurements of the dense atmosphere from top to bottom.

The flights, the first ones devoted primarily to a study of the atmosphere and weather of another planet on a global scale, may shed new light on some of the most puzzling questions in planetary science, such as: Why do two planets (Venus and Earth) with about the same mass, probably formed out of similar materials and relatively close together in the solar system, have atmospheres that have evolved so differently that the surface of Venus is baked by a searing heat, while Earth luxuriates in a climate friendly to life? The answer depends on an understanding of the factors that govern the evolution of a planet's atmosphere.

Information gathered by the 30 Pioneer experiments on the composition, circulation and energy balance of Venus' atmosphere also may help us learn more about the forces that affect the weather on our own planet. They employ the largest number of vehicles ever used in such studies, and will make measurements at the greatest number of locations.

Flight planners also seek to learn more about the characteristics of the upper atmosphere and ionosphere of Venus, as well as the lower atmosphere. They will study the interactions of these regions with the solar wind—the continuous stream of ions and electrons flowing outward from the Sun—and the solar magnetic and electric fields.

Pioneer Venus 1 is the first U.S. spacecraft to orbit Venus, whose surface temperature (480 degrees Celsius), atmospheric pressure (100 times that of Earth) and permanent cloud cover have made it an enigma among planets. Launched May 20, 1978, the orbiter has flown more than halfway around the Sun on its seven-month journey (some 500 million kilometers), traveling outside the Earth's orbit for the first three months, and inside it for the last four months. At Venus, the orbiter will follow a highly inclined 24-hour orbit planned so that spacecraft events are timed, or matched, with days on Earth.

At periapsis (orbital low point), the spacecraft will come as close as 150 km to the surface, dipping into the thin Venus upper atmosphere, sampling its composition and making radar measurements of the surface elevations and roughness. (The hemisphere of Venus that is visible to Earth radar shows a basin the size of Hudson Bay, a mountain as great in extent but not as high the solar system's highest, Mars' Olympus Mons, and a 1,000-km long canyon. Scientists are anxious to see Venus' unexplored half.) At orbital high point (apoapsis) the spacecraft will be 66,600 km from the planet.

The Pioneer Orbiter also will take daily ultraviolet and infrared pictures of the thick clouds and atmosphere.

Experimenters will use precise orbital measurements to chart Venus' gravity field for calculation of planetary shape and density variations. The 12 orbiter scientific instruments will make a variety of other remote-sensing and direct measurements of the planet's atmosphere and surrounding environment.

The orbiter's primary mission has been selected to cover the time it takes Venus to make one revolution on its axis—243 Earth days. During that time Venus will rotate slowly under the periapsis of the orbit (point of closest approach) providing closeup radar mapping of the entire circumference. Also, since Venus circles the Sun in 225 Earth days, the primary mission more than covers the time needed to sample the upper atmosphere and ionosphere at all Sun angles.

The companion spacecraft, the Pioneer Venus 2 multiprobe, is made up of a transporter bus, a large probe and three identical smaller probes. Launched Aug. 8, the multiprobe took a more direct route to Venus than its sister craft, traveling 350 million km. The probes will enter the atmosphere at points spread 10,000 km apart over the planet's Earth-facing hemisphere. The large probe enters Venus' atmosphere near the equator on the day side. The day probe enters Venus' southern hemisphere on the planet's day side; the night probe, the night southern hemisphere on the night side; and the north probe, the north polar vortex, also on Venus' night side. Bus entry is in the southern hemisphere on the day side. The bus uses two instruments to obtain the data on the composition of the upper atmosphere, from 150 km down to 115 km altitude, before burning up shortly after atmospheric entry.

Injection into the orbit of Venus by Pioneer Venus 1, and the entry and descent of the four probes and

the bus through the atmosphere were critical operations.

The sequence of events was as follows:

- On Saturday, Dec. 2, Ames controllers oriented the orbiter for orbit insertion and the next day loaded command memory sequences. On Dec. 4, the orbiter passed behind Venus and nine minutes later the command memory fired the orbit insertion motor for 30 seconds, reducing velocity by 3,780 km/hr. Ten minutes later, the Orbiter emerged from behind Venus, and five minutes after that, telemetry confirmed retrofire.
- Five days later, Dec. 9, the probes were in position to make their hour-long descent through Venus' atmosphere. The four probes and bus which make up Pioneer Venus 2 were separated Nov. 15 and 19, while they were still some 12 million km from Venus. They were nearly dormant and operating on internal timers from that time to conserve battery power.
- Three hours before entry, command systems on board the three identical 90-kilogram north, day and night probes turned on heaters to warm up batteries, radios and oscillators. Half an hour later, the 320-kg large probe's command system awakened the craft, warming up batteries and radio.
- On Dec. 9, the large probe sent its first radio signal to Earth in 24 days when, at intervals of five, three and four minutes, the north, day and night probes sent a signal to the Deep Space Network (DSN), which took three minutes to reach Earth.
- Seventeen minutes before entry, the large probe data system began operating at 256 bits per second (bps), and its instruments were warmed up and calibrated.
- Large probe entry at 42,000 km/hr occurred a few minutes afterward, and seconds after entry, the craft's parachute deployed. The heat shield was jettisoned, and 30 seconds later all instruments were on. For the next 55 minutes, the probe returned a steady stream of data on each level of the atmosphere as it descended. Impact on the surface of Venus came about an hour later.
- After first radio contact with the identical north, day and night probes, data began to arrive at 64 bps. Instruments were warmed up and calibrated. The probes entered the atmosphere at three-minute intervals. A minute after entry, windows and doors opened and booms deployed to expose sensors related to atmospheric structure and heat-sensing experiments. During the next hour all three probes gathered atmospheric data.
- Some 16 minutes after entry, as Venus' atmosphere thickened, the data rate was reduced to 16 bps. The north, day and night probes landed on the surface 10,000 km apart at three-minute intervals.

Scientists believe that the coordinated Pioneer atmospheric data, combined with similar data to Mars, Jupiter and other planets, will lead to a better understanding of atmospheric mechanisms in general. Studies of the interactions of temperatures, pressures, composition, clouds and atmospheric dynamics different from Earth's should provide insights into important mechanisms which are often prominent on another planet. Such findings may help us to better understand the Earth's complex weather machine.

Scientists think Venus may be an unusually good place to study the mechanics of atmospheres because the planet rotates very slowly and there are no oceans. The atmosphere appears to be a relatively "simple" weather machine, and the basic atmospheric circulation should be a simple hemispheric overturning. Hence, continuous measurements from orbit, combined with those of the probes from many points in the atmosphere, could provide at least a broad view of Venusian weather processes.

Because of its high density, temperature and corrosive constituents, the atmosphere on Venus presented a difficult problem for entry craft designers. The high entry speeds of 42,000 km/hr added to the problem, as did the necessity that all instruments either have observing or direct sampling access to the hostile atmosphere.

All four probes are geometrically similar. The main component of each is a spherical pressure vessel which houses instruments, communications, data, command and power systems. The large probe weighs 316 kg, is 1.5 meters in diameter, and its seven instruments weigh 28 kg. Each of the smaller north, day and night probes weighs 93 kg, are 0.8 m in diameter, and their three experiments weigh 3.5 kg.

The transporter bus is a spin-stabilized, short cylinder 2.4 m in diameter, housing instruments, communications, navigation and power systems. The exterior of the bus cylinder is covered with power-generating solar cells.

The orbiter spacecraft, like the bus, consists principally of a spin-stabilized 2.4-m diameter, short cylinder containing most spacecraft systems. Above the cylinder is the narrow-beam, parabolic dish antenna. The dish, used for high-speed data transmission, faced toward the Earth throughout the

mission, while the spacecraft spun beneath it. Within the cylinder is a thermally-controlled equipment compartment, which houses the 12 orbiter scientific instruments, a million-bit data memory and the communications and data-handling systems. The orbiter weighs 580 kg with 45 kg of scientific instruments. Weight in orbit after motor burn was 372 kg.

Venus, destination of Pioneer Venus, is the second planet from the Sun and the closest one to Earth. Because of its highly reflective cloud cover, it is the brightest object in the sky after the Sun and the Moon. Its mean distance from the Sun is 108.2 million km, or nearly three-quarters of Earth's distance from the Sun. When Venus is closest to Earth, directly between Earth and Sun, the planet is only 42 million km away. Since Earth and Venus are almost twin planets, scientists want to know if there is any chance of Earth becoming a desolate world like Venus.

The atmosphere of Venus appears to be predominantly carbon dioxide—about 97 per cent. Only tiny amounts of water vapor have been detected in it. The high density of Venus suggests a core something like Earth's nickel-iron core. Because Venus has no significant magnetic field, the planet has no magnetosphere and its unshielded upper atmosphere interacts directly with the solar wind.

Venus receives almost twice as much solar radiation as Earth, but it also reflects more than half of this, so the net solar heat is about the same as that on Earth. The high temperature on Venus occurs because the atmosphere traps the heat which creates a "greenhouse effect," meaning that the atmosphere allows passage of incoming solar radiation, but restricts outward radiation.

The temperature at the poles of Venus is only about 10 degrees C less than that at the equator, and its day and night hemispheres have about the same temperature. Hence, the massive atmosphere contains circulation mechanisms that distribute solar heat evenly over the whole planet. In addition to carbon dioxide, sulfuric acid, and traces of water, the atmosphere also has some carbon monoxide, hydrochloric acid and hydrogen fluoride.

Permanent clouds on Venus are very tenuous, resembling terrestrial smog. Data from Soviet Venera landers suggests that they are almost twice as deep as Earth's cloud region, about 18 km thick, and may be composed mainly of sulfuric acid droplets. These data suggest that below the bottom of the main cloud layers the temperature becomes great enough for the sulfuric acid droplets to evaporate into water vapor and sulfuric acid vapor. A clear atmosphere results. Enough sunlight gets through the clouds so that the surface appears as bright as on an overcast day on Earth.

On the basis of the earlier Mariner cloud photographs in ultraviolet light, it appears that the cloud tops are in continuous motion, traveling about 360 km/hr and circling the planet in four Earth days, but the Soviet Venera landers showed that wind speeds in the deep atmosphere are much less. An abrupt change in wind velocity appears to take place about 56 km altitude between the base of the clouds and the clear atmosphere below.

Some major questions relating to Earth and Venus are:

- Could the Earth's greenhouse effect become strong enough to cause a serious, steady rise in temperature? Like Venus, the Earth has a "greenhouse" condition which may be growing because of increases in carbon dioxide in the atmosphere. This may be attributable to large-scale burning of fossil fuel since 1850.

- Because Venus presumably formed as near the Sun as it is today, a distance not greatly different from that of Earth, we might expect Venusian oceans like our own. Yet there is almost no water on Venus. Where did the water go, if it ever existed? A suggested explanation is that because of a difference in distance from the Sun of Venus and Earth at the time they formed, a big difference in the amount of hydrated minerals incorporated in the protoplanets might have occurred. In that view, Venus has always been deficient in water. Another proposed explanation is that the water vapor outgassed by Venus never condensed into a liquid because Venus is too close to the Sun. In time, the water vapor was split by sunlight into its constituent hydrogen and oxygen, with the hydrogen being lost to space.

Cost of the Pioneer Venus spacecraft, scientific instruments, mission operations and data analysis is about $175 million.

The Pioneer Venus project is managed for NASA's Office of Space Science by the Ames Research Center, and the spacecraft are controlled from the Mission Operations Center at Ames. The spacecraft were built by Hughes Aircraft Co., El Segundo, Calif. The scientific instruments were supplied by NASA centers, other government organizations, universities and private industry.

Pioneer Venus 1 and 2 are tracked by NASA's Deep Space Network, operated by the Jet Propulsion Laboratory, a government-owned research facility managed for NASA by the California Institute of Technology.

Seasat Data Under Study

Although Seasat, NASA's experimental oceanographic satellite, was declared dead in mid-November, the spacecraft collected significant amounts of data during its 106-day lifetime. Processing of that data at NASA's Jet Propulsion Laboratory is expected to take more than a year-and-a-half.

Seasat was launched June 26, 1978, from Vandenberg Air Force Base, Calif., and contact was lost with the satellite on its 1,502nd orbit of Earth Oct. 9, 1978, when a short circuit drained all power from the batteries.

Seasat's synthetic aperture radar completed some 300 data-gathering passes during which it collected about 60 hours of data including images of sea ice, waves, coastal conditions and various land forms. The spacecraft's scatterometer (sea surface wind speeds) and scanning multifrequency microwave radiometer (sea surface temperature and wind speed) collected data for 99 days; the altimeter and visual and infrared radiometer returned data for 70 and 52 days respectively; and a series of sea surface, fact-finding experiments were completed.

Objectives of the Seasat program, a proof-of-concept mission, were threefold:

- to demonstrate techniques to monitor the Earth's oceanographic phenomena and features from space on a global scale;
- to provde oceanographic data in a timely fashion to scientists who study marine phenomena and to those users who regard the oceans as a resource, namely maritime interests, fishermen, marine geologists etc.;
- to determine the key features of an operational (full-time) ocean monitoring system.

Preliminary analysis of the Seasat-collected data by teams of scientists, engineers and user representatives indicates that the first of the above objectives will be largely met and a high probability exists of fulfilling the major part of each of the other objectives.

Members of a board to investigate the failure of the Seasat spacecraft were named by NASA soon after the Oct. 19 appointment of Dr. Bruce Lundin, former director of NASA's Lewis Research Center as chairman.

The members are: Parker V. Counts, Science and Engineering Department, Marshall Space Flight Center; James E. Hannigan, Flight Control Division, Johnson Space Center; Maj. James T. Mannen, U.S. Air Force Space and Missile Systems Organization; T. Bland Norris, director of the Astrophysics Division, NASA Office of Space Science at headquarters; Daniel J. Shramo, director, Space Systems and Technology, Lewis Research Center; James E. Stitt, director of electronics, Langley Research Center.

Affiliates to the board are: Merland L. Mosenson, director of Flight Assurance, Goddard center liaison; Charles H. Terhune, deputy director, NASA Jet Propulsion Laboratory, JPL liaisón; Robert F. Kinberg, NASA legal counsel; and Dell P. Williams, NASA Office of Aeronautics and Space Technology, executive secretary.

In a letter to Lundin in which the board members were named, Dr. Alan M. Lovelace, NASA Deputy Administrator, cited the importance of their investigation, saying that: "the board should move as expeditiously as possible, consistent with a thorough analysis of the facts, to determine the actual or probable causes of this mission failure." Lovelace further assured Lundin that appropriate NASA resources and all background information would be made available to the investigation board members.

The NASA document establishing the board charges members with the responsibility to: determine the actual or probable cause(s) of the Seasat mission failure and document the technical and management history of such cause or causes; provide a final written report to the Deputy Administrator; carry out any other responsibilities that may be requested by the Deputy Administrator.

NATO Communications Spacecraft Launched

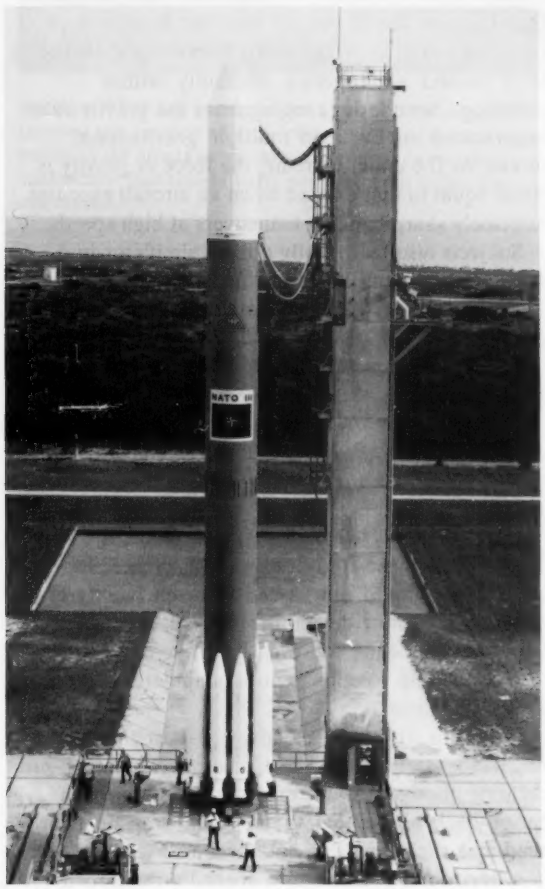
NATO III–C, the third and final communications satellite in a new series to serve the North American Treaty Organization, was launched Nov. 15, by a Delta rocket from the Kennedy Space Center. Under terms of a U.S.-NATO agreement, NATO is obligated to reimburse NASA $8.9 million for the launch vehicle and launch services.

The satellite provides an in-orbit backup to the NATO III–A and B satellites in the NATO Integrated Communications System. It orbits the Earth

once every 24 hours at a geosynchronous altitude of 35,900 kilometers.

The Delta project is managed by the Goddard Space Flight Center for NASA's Office of Space Transportation Systems. Kennedy Space Center is responsibile for launch operations. Prime contractor for Delta is McDonnell Douglas Astronautics Co., Huntington Beach, Calif.

Four previous NATO satellites were launched successfully by Delta—the NATO II–A and B spacecraft in March 1970 and February 1971, the NATO III–A in April 1976, and NATO III–B in January 1977. The NATO III spacecraft were built by Ford Aeronutronic and Communications Corp., Palto Alto, Calif., and were funded entirely by NATO.



Ready for Orbit—Communications satellite NATO III–C as it awaited launch at Complex 17, Cape Canaveral. The spacecraft is in orbit above the equator in the Atlantic Ocean.

Women Complete Extensive Space Tests

Many programs are carried out at NASA centers in a continual effort to find out how humans adapt to conditions approximating those to be encountered in outer space. Risks must be defined and remedies invented before Earth dwellers can live and work in the alien atmosphere of an orbiting satellite.

In early November, eight women volunteers in the 45- to 55-year age group were released from the NASA Human Research Facility, hale and hearty after nearly a month spent in complex and rigorous tests, isolated from personal contact with friends and family, at the Ames Research Center.

The group, along with some 40 other men and women aged 25 to 55 who have offered their services to the space program since 1973, served as participants in a study designed to assess the effects of weightlessness on the human body. Of particular importance to the research are measurements of the tolerances and responses of the body as it re-enters the gravity-laden atmosphere of Earth after experiencing the zero gravity of space.

The long-term NASA experiment, informally known as the "Bed Rest Program" will be completed probably in the next 12 months as two more groups—eight men, then eight women, all in the 55 to 65 age bracket—undergo the same tests as the earlier subjects.

The latest set of recruits, all Californians, to come through with flying colors are:

Eleanor Belton, 52, supervisor at an engineering company

Barbara Goddard, 48, housewife

Dale Graves, 53, pilot and retired Navy captain

Mary Ellen Joseph, 49, housewife

Diana Larsen, 45, housewife

Madelyn Luthi, 55, housewife

Bernice Robertson, 51, chief of a maternal-child health board

Joanne Walsh, 51, court reporter and housewife.

Like all the rest, the women were cheerful and enthusiastic ("superb, highly motivated," said facility manager Dee O'Hara), several saying they were eager to join in similar NASA experiments again. The same reactions have been voiced by other subjects, some of whom call the Ames center regularly to offer their services.

The medical research program is conducted by members of the Biomedical Research Division at the

Helping toward Living in Space—Voluntary subjects in tests to determine the strengths and weaknesses of people staying in space for prolonged periods recently finished the latest bed-rest experiment. Left to right are, back row: Eleanor Belton, Joanne Walsh, Madelyn Luthi, Barbara Goddard; in front row, Dale Graves, Diana Larsen, Bernice Robertson, and Mary Ellen Joseph.

Ames center, under the direction of Harold Sandler, M.D. He is assisted by Danielle Goldwater, M.D. Ralph Pelligra, M.D., is the medical qualifying officer for the candidates. The facility manager is Dee O'Hara, R.N. (She has been the nurse on all NASA's manned space missions, from the Mercury program to the Apollo Soyuz Test Project.)

The reason for using bed rest to measure bodily responses is that prolonged horizontal bed rest is one way by which a physiological approximation of the zero gravity experienced in space can be achieved on Earth. Bodily changes begin within 24 to 48 hours after total bed rest begins and continue to develop throughout the subsequent days of the bed rest period.

Once zero gravity has been approximated, medical researchers can study human responses to the introduction of both normal and abnormal Shuttle re-entry gravity forces. Other tests assess the value of anti-gravity suits as a protection against the stresses during re-entry, this a cooperative study series with the Johnson Space Center.

So far nobody has suffered serious physical changes. Most said that discomfort and boredom were their only adverse reactions, but that the chance of participating in a space program more than made up for such minor distress. The extent of risk is considered minimal on the basis of testing to date and medical examinations afterward have disclosed only minor differences in reactions of age groups and sexes.

By now, the selection system for the program is well-established at the Ames center. At the start of each segment, a preliminary selection is made from among some 200 volunteers in a specific age group. They respond to advertisements run in the sports or society pages, a very successful gambit instigated by Lynne Dunham at Ames, who screens the subjects and makes a preliminary selection.

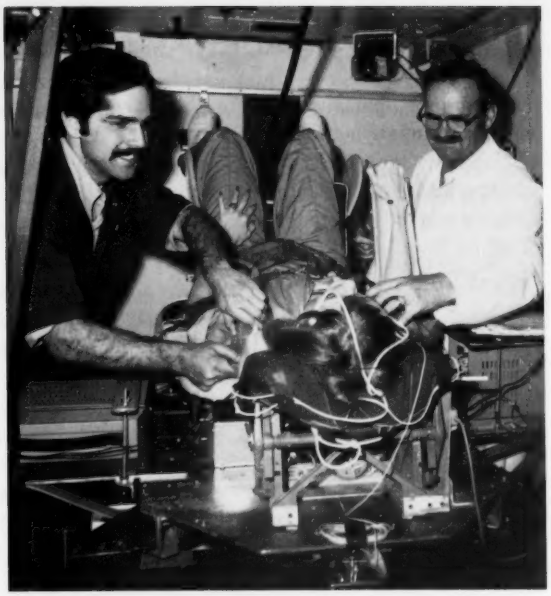
The pre-selected group is given a series of exacting physical and psychological tests each day for a week, takes short orientation rides on the human centrifuge at different speeds, and goes through lower body negative pressure tests for evaluation of blood and heart functions. In short, to qualify for the full experiment, subjects must first pass tests demonstrating that their circulatory system functions well, that they have no blood defects and that they have good lung functions. They also must demonstrate an ability to withstand and operate efficiently within centrifuge boundaries ranging from the gravity rates experienced on Earth to multiple gravitational forces. At the upper extreme, the force of gravity is about equal to that exerted when an aircraft executes extremely sharp banking maneuvers at high speeds.

Subjects also learn to fly a flight simulator in a sitting position and lying down, since during the bed rest study, all test procedures are done from a supine position.

At all times, medical personnel keep a sharp eye on actions and reactions. Individuals can halt the testing any time they choose. Volunteers are repeatedly told what they can expect, the reasons for the various procedures and the philosophy behind the research program.

When the final selection has been made, the first of the three-phase study begins when the eight subjects move into the 12-bed research facility at Ames. After a nine-day control period, 10 days of total bed rest begin, followed by a five-day recovery period with the volunteers in an ambulatory status but still confined.

Rules are strict as tests advance. Participants must stay flat constantly during bed rest experimenting, no cheating allowed. About the only variation on the flat-on-back rule is that subjects can prop up their head at a slight angle to eat. Even showers are taken in a horizontal position in a specially developed shower into which a subject is moved via a wheeled gurney that slides under a bank of nozzles. Medical supervision is constant.



Taking a Whirl—A woman in the Ames bed-rest program is fastened into position on a centrifuge during preliminary testing of the effects of weightlessness on a human body. Technicians Dan Gundo (left) and Sil Corpus adjust the contraption.

Dining on the Horizontal—One of the bed-rest volunteers at the Ames center demonstrates how the difficult feat of eating without moving more than a few inches up from a flat position is accomplished.

No visitors are allowed though incoming and outgoing telephone calls may be made. No smoking, no alcoholic beverages, no candy or snacks, no drugs or medication unless prescribed by the attending physician, no dieting, no deviation from three meals a day, lights off at 11 p.m., on at 7 a.m.

At times the lower body is placed in a box for negative pressure tests, which measure the amount of bloodflow through the legs as pressure is lowered within the box. The test also measures the size of the heart and how fast it squeezes blood into extremities. Blood samples are taken throughout each day, as well as deep body temperatures. Electrocardiograms constantly record the heart rates of each individual, even during sleep. A "biobelt" worn constantly around the waist contains antennae that sends various kinds of data to recorders in another room.

Centrifuge rides take place before and during bed rest. They are designed to measure reflexes and coordination as the body makes its adjustments to the strange circumstances.

Every effort is made at the Ames facility to keep subjects cheerful and relieve the natural boredom that sets in after the initial excitement has subsided. Surroundings are painted in bright corals and yellows with colorful wall decorations. Many books and games are at hand and each of the beds is equipped with stereo and color TV. Rooms (two beds in each) are soundproof. The residential area contains a lounge, recreation and dining areas, a kitchen, several bathrooms and a nursing station with phone communication to each bed. The food is well prepared, nourishing and attractively served. O'Hara's long experience with astronauts causes her to be extra sensitive to the discomforts of long confinement in cramped quarters, so she strives for cheerful upbeat surroundings. Even the jumpsuits provided for the women while they are ambulatory are fashioned from colorful fabrics.

Medical attendants, consisting of doctors, nurses and technicians, are on hand at all times, and remote monitoring of physiological functions provides continuous recorded data about each subject. All these factors combine to reassure the volunteers and to make them feel safe and comfortable. And they know they can withdraw at any time. But only one person has ever dropped out of the test series, a withdrawal caused by family difficulties.

Unique Martian Feature Spurs Scientific Investigation *

The mystery of Mars has captivated humanity for generations. NASA's Mariner 9 dispelled a great many myths as it photographed and studied 95 percent of the Martian surface. And Viking, with its matched set of orbiters and landers, came along to solve more mysteries. But many questions remained, and for the scientific community the answers only seemed to generate more questions.

Despite the wealth of data that has come down from the Red Planet via NASA-JPL automated spacecraft, Earth's nearest planetary neighbor continues to spawn a host of unanswered—and maybe some unanswerable—questions.

One of the paradoxes that so far has eluded scientific explanation is the "White Rock," a common-enough name given to a unique topographic feature nestling inside a crater not far from the Martian equator. Since White Rock's discovery by Mariner 9, scientists have been intrigued by the reflectivity of its unknown basic material, and by the fact that apparently no other formation on Mars resembles it.

In shape, at first glance White Rock resembles the pawprint of some strange, many-toed animal. Almost rounded on two-thirds of its perimeter, White Rock's remaining great serrated formations reach like claws into the floor of the surrounding Martian crater. These are referred to as "reentrants" and "dunes" in scientific terminology.

White Rock's probers believe the ridged area is being eroded by the ever-present Martian surface winds. "It's an elusive enigma," comments Nancy Evans, resident team leader for Viking orbiter imaging at JPL. She is spearheading a NASA-JPL quest to better understand the unique feature.

The possibility of the surface being ice-covered was rejected early because of its proximity to the equator. Its mineral composition has been hypothesized as either salt or sand.

Roughly 18 kilometers across, White Rock appears to rise from the floor of an impact crater some 93 km in diameter. Very small impact craters on the floor of the larger crater and on the feature itself may help scientists to an understanding of the age of the formation in relation to its surroundings.

Although labelled "white," general opinion is that the feature has a very light orange or pink tint.

After Mariner discovered the unique feature, Viking was programmed for a closer, more definitive look. "Viking's more sophisticated vidicon offered us a factor of five better resolution at a similar altitude," Evans said.

The images, put in mosaic form to provide the photo accompanying this article, were produced by Viking in a sequence to obtain both stereographic and spectral information. Computer processing of these data is expected to help the search for an explanation of White Rock.

*Reprinted from JPL *Universe*.

The Abominable Snowman Prowling Mars?—Viking's cameras recorded this remarkable Martian feature—the inside of a crater—last September from 1,135 kilometers above the surface. Its composition and the history of its formation are not understood, but a geological investigation of the matter is underway at JPL.

NASA Seeks Venus Science Experiments

NASA is asking scientists to propose experiments for a 1984 planetary mission designed to provide the first global view of the surface of Venus. The mission will be accomplished by the Venus Orbiting Imaging Radar to be launched by the Space Shuttle. VOIR will circle the planet for at least seven months, taking radar pictures and making measurements of the atmosphere and the surface of Venus in the most detailed scientific examination ever made of the exterior of that cloud-covered planet.

Dr. Noel W. Hinners, NASA's Associate Administrator for Space Science, emphasized that VOIR has not been approved, but said that early selection of scientific participants and investigations allows for advanced studies to assure a well-defined program when approval is received.

In announcing the solicitation for scientific investigations, Hinners said:

"NASA is engaged in a continuing program of space exploration., a major part of which is directed at the solar system. The VOIR program is a key step in that endeavor.

"While considerable knowledge of the Venus atmospheric properties will be forthcoming from the Pioneer Venus mission, and while the Soviet Venera missions have provided valuable data on surface properties at three localities, information regarding the surface morphology on a global scale—and all of the insights that this scientific information provides—is lacking. A major technical goal of the VOIR mission therefore is to obtain global radar imagery with sufficient resolution to address fundamental questions regarding the origin and evolution of the planet, and to lay the groundwork for subsequent, more detailed investigations of the surface and interior."

Hinners said VOIR will lend itself to study of a number of problems that will not be fully explored by the Pioneer Venus mission. The Pioneer Venus mission calls for a spacecraft to orbit the planet for one Venusian day (243 Earth days) and a probe-carrying bus to study the planet's atmosphere in detail on a global scale. The study began last month.

According to present plans, NASA would launch one spacecraft from the Shuttle to Venus in 1984. A typical trajectory would begin in December 1984 and provide for arrival at Venus in May 1985. The spacecraft then would be inserted into an elliptical parking orbit, to remain there through May and June 1985 while the NASA Deep Space Network is occupied with the Galileo project (a 1984 deep probe mission to Jupiter). In late June or early July, a propulsion maneuver would place VOIR into a near-polar orbit at an altitude of 300 kilometers.

Radar mapping and other science gathering would begin in July and continue for five months. The mapping activity would result in near-global coverage of the planet in moderate resolution (about 1 km) imagery, and coverage of a small percentage of the planet's surface in higher (about 100 km) resolution pictures.

Venus has yielded her secrets with great reluctance, principally because of the obscuring clouds, crushing atmospheric pressure (a hundred times that of Earth) and searing temperatures (480 degrees). Several American and Soviet probes have penetrated the planet's atmosphere and transmitted important data for periods ranging from minutes to hours, but none has provided a satisfactory picture of the Venusian surface. Two probes, the Soviet Union's Venera 9 and 10, carried an imaging instrument which survived impact, but the pictures showed very little.

The VOIR imagery is expected to disclose the presence or absence of continents, ocean basins, mountain belts, rift valleys, fault belts or volcanoes. The nature and time sequence of plate tectonic activity (continental drift) may also be revealed, as well as any relation between such drift and volcanic episodes in the history of the planet. If impact craters are present, as suggested by Earth-based radar observations, their size and frequency can be determined.

Other scientific investigations will be conducted that relate to the planet's fundamental geophysical atmospheric problems.

The VOIR orbiter—to weigh about 5,000 kilograms at launch—will consist of a bus with a synthetic aperture radar and other science instruments. Earth) and searing temperatures (480 degrees C). Final date for receipt by NASA of proposals is Feb. 2, 1979. All other scientific proposals must be in by March 16, 1979.

Letters of intent to propose should be submitted to Dr. W. L. Quaide, Code SL-4, NASA Headquarters, Washington, D.C. 20546.

Worldwide Wheat Crop Studied

Global wheat production has been monitored in the recently completed Large Area Crop Inventory Experiment (LACIE), which employed space-age technology for the survey.

Results were presented at a four-day symposium at the Johnson Space Center, attended by more then 700 conferees from 22 nations. They represented federal agencies, private companies, universities and the foreign governments. LACIE participants, consisting of NASA, the Department of Agriculture, the National Oceanic and Atmospheric Administration of the Department of Commerce, cooperating universities, and industry representatives, discussed findings.

The experiment was begun in 1974 to determine whether data from the Landsat satellite could be used in combination with surface weather observations and information derived from U.S. operational environmental satellites to predict production of wheat, the world's most important grain crop. Landsat orbits at about 917 kilometers above the Earth.

The major foreign areas of study were Canada and the Soviet Union, with preliminary examination of wheat-growing areas of Australia, the People's Republic of China, Brazil, India and Argentina. The U.S. Great Plains was used extensively to test and evaluate the several techniques because it was the best source of statistical data with a known reliability.

The LACIE techniques were intended to increase the accuracy of existing global forecasts of wheat production by improving foreign production forecasts and to do so as early in the crop season as was possible. The accuracy goal set by the project was to develop a system that would provide estimates accurate to within 10 percent of true production at harvest in nine of ten years.

In tests concentrated on the winter wheat area of the Great Plains, it was determined that the accuracy standards could be met. When the techniques were used to monitor the Soviet wheat crop harvested in 1977, the LACIE produced a production estimate of 91.4 million metric tons, less than one percent below the official mark of 92.0 million tons released by the Soviets. The capability to achieve such accuracy from year to year has yet to be demonstrated, however.

In other study areas such as the spring wheat regions of the U.S. and Canada, where long narrow fields are hard to distinguish and where wheat can easily be confused with other spring-planted crops, the accuracy goal was not met. A most important result, however, was that LACIE was able to determine the reasons for not meeting its goals in such areas and to identify what steps need be taken to achieve the desired results. Future satellites with improved resolution should allow smaller fields to be identified with accuracies similar to those shown in the Soviet Union where large fields are typical.

A peer evaluation team composed of prominent scientists and chaired by Dr. Don Paarlberg, former Director of Economics for USDA, reviewed the LACIE techniques and presented its report at the symposium. Paarlberg stated that, "LACIE results to date clearly demonstrate that present remote-sensing capabilities can be combined with, or substituted for, conventional methods of information collection to improve foreign crop production estimates." He concluded the evaluation of the results by saying, ". . . for global wheat regions such as the U.S.S.R. the LACIE technology can be made operational and for regions where the technology requires improvement, funding for further research and development should be continued."

NASA, USDA and NOAA, which collectively provided the many different skills necessary to make LACIE a success, are now defining a follow-on activity to extend the application of space-age technology to agriculture. USDA has established an office in Houston near the space center to test the usefulness of LACIE technology in crop condition assessments.

Subsidiary benefits resulted from the LACIE experiment, primarily in meteorological research. NOAA scientists used the techniques they developed to relate crop yields to weather, and devised mathematical formulas for relating temperature to home-heating fuel consumption. These have been used in conjunction with extended forecasts during the past two years for projecting information about areas of the country in which estimated consumption would be higher or lower than normal, thus allowing for more efficient allocations of fuel to satisfy actual need.

The Evolution of a NASA Budget

When January approaches, the budgets of federal agencies become matters of paramount importance to many people, both in and outside government. Public statements, conjecture by all sorts of experts, media comment, and various other kinds of attention are heaped on this all-important topic. But its staggering complexities make it all but incomprehensible to most people.

Howard Roseman, head of program evaluation in NASA's program budget and control division, Space Shuttle program, tries to set matters straight in the following article. Among Roseman's duties is the planning for Congressional presentations, and, in general, riding herd on matters related to the budgetary progress of the Shuttle through Congress.

Within the next few months, NASA *Activities* will be listing the President's budget submission to Congress as it affects NASA. If you are bewildered by these numbers and the continuing news stories concerning budgets, authorizations and appropriations for various government agencies, you are not alone. The disbursing of funds required to run the departments and agencies is most complex.

In brief, this is how the system works: Each January, after his State of the Union Message, the President submits to the Congress his budget message

with recommendations for government expenditures for the year that begins Oct. 1. This budget is prepared for him by the Office of Management and Budget, an executive agency which compiles the yearly budget estimates from all the departments and agencies. OMB balances the estimates against the expected federal income and the recommendations of the President and his political advisors. The President is the first one to review and revise the proposals for distribution of budget funds. The total budget summary submitted to Congress is the size of a large telephone book with well over 1,000 pages. It contains hundreds of charts describing funding details of the various government agencies.

Before money is appropriated to an operating department, legislative evaluation is usually performed. The President's budgetary requests are reviewed by the cognizant legislative committees in both the House and Senate. After their evaluations, they report to their respective Houses. Each House may produce an Authorizing Act as required, which recommends an upper limit on the money that should be appropriated each year. Following passage of an Authorizing Act agreed upon by both Houses of Congress, an appropriations bill must be introduced, passed by both Houses, and signed by the President before the Treasurer is empowered to disburse funds. All funds requested for NASA are evaluated by these legislative committees.

The appropriations committees usually follow the maximum set by the Authorization Act, and the appropriations bill is often less than the authorization. Any changes are usually of an across-the-board nature, but they may also include funding changes for specific items. The Senate and House Appropriations Committees recommend appropriations to their respective chambers which then pass appropriation bills. By custom, appropriations usually originate in the House of Representatives. Any differences are resolved by a conference committee with members from both the House and Senate until finally a single appropriation bill is given to the President for signature.

In the case of the NASA budget, the House Committee on Science and Technology has several subcommittees which review the budget request and report on an authorization bill. In the Senate, the Committee on Commerce, Science and Transportation has the authorization recommending responsibility. These two groups make essentially independent assements of the agency budgets by means of investigations and hearings.

But you are probably asking—"What do the agencies do after Oct. 1 if the appropriations bill has not yet been passed?" They are supplied funds via the use of a "Continuing Resolution," which must be passed periodically by Congress. Until the appropriation is approved, various funding formulas are applied to the different agencies. This allows an agency to continue spending at a rate which may be the monthly rate based on an average of the sum of money expended in the previous year.

After the agency receives its appropriation, its use of funds is governed by the Authorization Act. If permitted by law, the agency may "reprogram" some portion of its authorized funds to projects other than those authorized. In a research and development agency, such action can occur quite often since the budget is prepared so far in advance that it is unable to account for the many changes that may take place. Even within a given program (a "line" item), money may be allocated in a somewhat different manner than originally planned to accommodate funding requirements.

If the agency finds that the approved funds appropriated are inadequate to cover its expenditures, it may go back to Congress for "supplemental" appropriations. It may request from the Appropriations Committees up to the total amount allowed by the Congressional Authorization. The agency also may go back and request more funds from OMB, if necessary. The President then may decide to request additional authorization and appropriation of funds from Congress.

The following chart summarizes the approximate status of the NASA FY 1979 budget:

Budget request (by President)	Jan.	$4,371.6 Million
House authorization	Sept. 19	+43.7
Senate authorization	Aug. 17	+17.0
Final atuhorization (after conference)	Sept. 30	+30.0
House appropriation	Sept. 19	−37.7
Senate appropriation	Sept. 20	−18.4
Final authorization (after conference)	Sept. 30	−21.4

So we can see that although Congress authorized $30 million more than NASA requested, $21 million less than requested was finally appropriated. The final budget figure for NASA is, therefore, $4,350.2 million.

One aspect not covered in this discussion of the budget process as it applies to NASA is the important

Budget Committees. One is on the House of Representatives and one in the Senate. In addition, a group of senior economists makes up the Congressional Budget Office. This office advises Congress on economic forecasts concerning government income, effects of Congressional appropriations, deficit estimates, and inflationary trends. The information thus provided, along with other spending and tax forecasts, is reviewed by the two Congressional Budget Committees, which finally recommend levels of spending, revenues and public debt, and the amount of budgetary surplus or deficit which seems appropriate. Their recommendations come after the first review by the President, and before the proposed budget reaches legislative House and Senate committees.

Congress adopts tentative budgetary targets by May 15 in the form of a first concurrent resolution. After legislative hearings and various money bills have been passed, Congress reviews earlier budgetary goals and adopts a second concurrent resolution in September. At this point, conditions may have changed—perhaps the rate of inflation, for instance, may have dropped or risen—and the Budget Committees may revise their figures. This system demands a great deal of Congressional self-discipline and commits Congress to a top limit for appropriation which is reconciled with government income and economic conditions in the country.

Landsat to Help Explore for Gas

NASA has signed an agreement with the Appalachian Regional Commission to test and evaluate the use of Landsat data as an aid to the identification of gas shale exploration areas of high potential in Appalachia's eastern Devonian shale region.

The Appalachian Regional Commission is a consortium of 13 member states: Ohio, Kentucky, West Virginia, New York, Pennsylvania, Tennessee, Virginia, Alabama, Georgia, Maryland, Mississippi North Carolina and South Carolina, plus a federal co-chairman appointed by the President. Its objective is to build a better economy in the Appalachian Region. This project is one of a series under NASA's Landsat application systems verification and transfer program.

Landsat spacecraft orbit at an altitude of about 917 kilometers, surveying the Earth's surface to obtain remotely-sensed data in various bands of the energy spectrum (visible and near infrared). These data, in the form of images and computer-compatible tapes, are proving useful to a wide range of interests—agriculture, geology, forestry, range resources, mapping and charting, land use management and water resources.

Appalachia, an area of nearly 518,000 square km and 19 million inhabitants, is rich in natural resources, but the full rewards of its natural wealth have never been realized. For many years the region has suffered from economic distress.

The Devonian shales with which this project is concerned are under an area extending from the Mississippi Basin to the Appalachian Mountains. (Other Devonian shale areas are located in the Michigan basin and under the southern parts of Indiana and Illinois and western Kentucky.) Formed about 350 million years ago, their multitude of plants and animals are preserved in a rich organic legacy of natural gas. The gas is found in sealed fractures or cracks in the Earth's crust.

These fractures are easy to find when they are visible on the Earth's surface, but it takes sophisticated measuring and sensing devices, such as the Landsat spacecraft, to detect and measure them when they lie beneath the surface, as they do in the Appalachian region. One of the features of Landsat imagery is that it enables geologists to locate and identify large faults and fractures, the scope of which would not be detected fully by ground or aircraft observers.

Plans call for use of the Landsat data in the analysis of features in three test areas:

- at the intersection of Ohio, Kentucky and West Virginia, centered at Huntington, W. Va.;
- bordering New York and Pennsylvania, east of Lake Erie, centered at Bradford, Pa.;
- intersection of Kentucky, Virginia and Tennessee, at a point east of Middlesboro, Ky.

The data would be used to locate and identify linear traces on the surface that would signal the location of faults and fractures to be designated as likely drill sites.

The commission and its member state agencies and associated institutions then could use these data in the evaluation of areas of high potential for natural gas exploration and associated development. Evaluation techniques and test phase information will be provided to geologists and planners in state offices and other organizations with similar needs.

The memorandum of understanding between the commission and NASA was signed by Robert W.

Scott, ARC Federal Co-Chairman, and Dr. Anthony J. Calio, NASA Associate Administrator for Space and Terrestrial Applications. Project managers are Hugh B. Montgomery of the ARC in Washington, D.C. and Arthur T. Anderson of the Applications Directorate at NASA's Goddard Space Flight Center.

NASA Ends Plan for Skylab Reboost/Deorbit

NASA has discontinued planning efforts to reboost or deorbit the Skylab space station now orbiting Earth. Termination of the planning for this mission is because of the limited potential for success. Because of uncertainties that have developed in Skylab systems and lifetime, Space Shuttle schedule, and delivery of the Teleoperator Retrieval System, further planning for the mission was deemed impractical.

Some of the factors that led to the decision are:

- A deterioration of systems aboard Skylab, e.g., recurring control moment gyro anomalies, marginal power conditions and minimal attitude control impulse gas.
- Sunspot activity in recent months has been high, accelerating the decay of Skylab's orbit.
- Detailed reviews showed that a TRS mission on the second Space Shuttle flight would be difficult to accommodate before April 1980.

Skylab is in an orbit at about 370 kilometers altitude. It is being maintained in a low drag attitude and will be continually monitored while contingency plans for reentry are assessed. It is predicted that Skylab will reenter the atmosphere between mid-1979 and mid-1980, perhaps as early as May 1979. Most of the vehicle will burn up during reentry but some fragments are expected to reach the surface. Its flight path is 75 percent over the ocean. The chance of injury or damage in populated areas is considered to be minimal, even less than might be expected from falling meteorites.

International Affairs Officer Leaves NASA

Steve Doyle resigned his position as NASA's Deputy Director of International Affairs to accept the post of group manager, Office of Technology Assessment in the Congress, on Nov. 17. His duties at the new post will be to manage an assessment program on telecommunications and information system technologies. Doyle held his NASA position from April 1974 to November 1978. In 1977 he received the NASA Equal Employment Opportunity Award and Medal. No successor was named immediately.

Wind Turbine Conference Set

The marketing potential and technology status of large wind turbine electric generators will be reviewed at a conference for U.S. industry, Jan. 31, at the Lewis Research Center.

NASA is supporting the Department of Energy in developing, with the aid of U.S. industries, large wind turbine electric generators as a source of supplemental power for utility networks. The Lewis center is conducting a technology development program and an experimental program with the utility industry.

Lewis engineers believe that large wind turbines can become a cost-competitive source of electrical power not subject to depletion and that the time is right for additional industrial equipment designers and producers to become involved in the nation's wind energy program, a potentially large market.

G. Mervin Ault, director of energy programs at Lewis, said: "Our work has shown that large wind turbines are closer to meeting utility energy cost requirements than any other electric power system option available today."

Picturesque Generator—This 200-kilowatt wind turbine generator supplies about 20 percent of the electricity needed on the Island of Culebra, P.R.

Two advanced design wind turbines in planning stages will be discussed at the meeting. The first is a 200-kilowatt wind turbine that can operate at wind speeds lower than the wind turbines presently in operation. The second is in the 1,000- to 4,000-kW range that will produce electricity at a reduced cost per kilowatt hour over smaller scale units.

In the DOE/NASA experiment program with utilities, two 200-kW wind turbines are currently in operation on utility networks in Clayton, N.M., and Culebra, Puerto Rico. Another 200-kW machine is being assembled and installed on Block Island, R.I., scheduled to go into operation in 1979. A fourth is planned for placement in Hawaii in 1980. The world's largest wind turbine is being built and shipped to Boone, N.C., for erection and operation next year. This machine has two blades that span 58 meters from tip to tip and a 2,000-kW generator.

Because DOE and NASA studies have shown that larger machines have the potential for better economic return on investment, a 91-m–diameter machine capable of generating 2,500 kW of power is being designed. Four such machines will be built and put into utility networks in 1980 at locations not yet disclosed.

New Deputy Director at Ames

A. Thomas Young, presently director of the planetary program in NASA's Office of Space Science, has been named Deputy Director of NASA's Ames Research Center, effective Feb. 1, 1979.

Young assumed his current position in November 1976. Previously he served as mission operations manager and mission director of Project Viking, one of the responsibilities of the Langley Research Center. He joined the Langley center in December 1961, working on Project Vector until March 1965, when he became mission definition manager of the Lunar Orbiter project. In 1968, Young was assigned the responsibility for the development of Mars mission objectives for the Advanced Space Project Office (unmanned).

Young received the Langley center's Sustained Superior Performance Awards in 1967 for his contributions to the Lunar Orbiter project and in 1977 for his work on Viking. In 1977 he received NASA's highest award, the Distinguished Service Medal, for his contributions to Viking.

Born in Nassawadox, Va., Young earned the degree of Bachelor of Aeronautical Engineering and Bachelor of Mechanical Engineering from the University of Virginia in 1961. He was a Sloan Fellow at MIT in 1971–72 and received a Master of Management Degree.

Astronautical Society Honors Gillam

Isaac T. Gillam IV, director of the Dryden Flight Research Center, has been elected to a Fellowship with the American Astronautical Society. This level of membership is conferred in recognition of Gillam's significant contributions to astronautics. The newly elected Fellow was presented at the AAS awards luncheon held in conjunction with the 1978 AAS Annual Meeting in October. 1978.

Founded in 1952, the AAS has more than 1,000 members consisting of researchers, scientists, executives, educators and other professionals in the field of astronautics and related areas. They promote and support scientific research related to the development of astronautical sciences.

New Chief for External Relations

Arnold W. Frutkin was appointed NASA Associate Administrator for External Relations, effective in November. Since March 1978, he has served as Deputy Associate Administrator for External Relations, and, since June 4, as Acting Associate Administrator. Previously, he headed NASA's Office of International Affairs for 18 years.

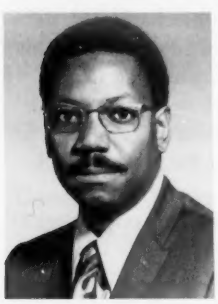
In his new position, Frutkin is responsible to the Administrator for the development of external policy and the coordination of NASA activities dealing with the public, the international community, universities, state and local governments and the Department of Defense and other federal agencies.

Before joining NASA, Frutkin was Deputy Director of the U.S. National Committee for the International Geophysical Year. A graduate of Harvard College, he did graduate work at Columbia University and

served in the U.S. Navy in the Pacific during World War II. He is a commander, USNR (ret.).

During his NASA career, Frutkin was also Adjunct-Professor at the University of Miami's Center for Advanced International Studies, 1969–1970; visiting lecturer and guest fellow at Yale University's Berkeley College, 1974–1975. He is the author of a book, "International Cooperation in Space," and numerous published articles. He has received the NASA Distinguished Service Medal, the NASA Exceptional Service Medal, the National Civil Service League Award and a number of awards from foreign governments.

College Post for Langley Man



Dr. Alvin F. Anderson, head of the Office of Research Grants and University Affairs at the Langley Research Center, is working at Hampton Institute for one year under the Intergovernmental Personnel Act, serving as the Assistant Director of Development for Federal Programs in the Office of Development. As such, he is responsible for establishing a program to increase federal funds for selected programs of the college as well as to increase the sources of federal support.

He spends half his time in Washington, D.C. and half at the Hampton Institute.

At Langley since 1972, Anderson served as the center's first Equal Opportunity Officer. He attended the Kings's Point Executive Institute before assuming his present position in 1975. He received his B.A. degree in sociology from Seattle University, his M.A. degree in counseling from John Carroll University, Cleveland, and his Ph.D. from the University of Virginia.

Before coming to Langley, Anderson Served as Associate Director of the Afro-American Studies Program and assistant professor in the graduate division of education at Hampton Institute.

Anderson served as director of counseling services at Voorhees College, Denmark, S.C., director of guidance services at Brown High School, Charleston, S.C., and as a counselor at the Luther Burbank School for Boys, Mercer Island, Wash.

New Fellow at Ames—Center director Sy Syvertson discusses a management text with Phyllis A. Hayes, who recently won the NASA/Civil Service Commission Education for Public Management Fellowship. Hayes has been a staff assistant in Ames' Life Sciences Directorate for some time. She holds a B.S. degree from the University of San Francisco and a Master's degree in management from the University of Redlands. The Civil Service Fellowship takes Hayes to the University of Washington in Seattle for an academic year.

High Award Given Lilly

William E. Lilly, Associate Administrator/Comptroller of NASA, was named as one of 10 winners of the National Civil Service League Career Service Awards for 1978. The awards were presented at ceremonies held Dec. 4 at the U.S. Civil Service Commission auditorium. The winners of the awards are selected on the basis of demonstrated efficiency, achievement, character and service, and they are nominated by agency and department heads.

Lilly's nomination cited "a varied and impressive career in public service." The nomination concluded: "It is widely recognized that NASA's major achievements have rested, as much on its ability to innovate and manage effectively, as upon its technical competence. In the management area, Lilly's contributions have been paramount and are fully deserving of the highest recognition."

A native of Liberty, Texas, Lilly participated in major campaigns in World War II while serving in the U.S. Navy. He graduated from the University of California in 1950 with highest honors in the School of Political Science and was a member of Phi Beta Kappa and Pi Sigma Alpha. He also completed a year of graduate work at the University of California.

Lilly began his career at NASA in 1960 as chief of plans and programs, Office of Launch Vehicle Programs, and was later designated director of program control, Office of Manned Space Flight.

Before joining NASA, Lilly was assistant to the director of plans and programs, Special Projects Office, Department of the Navy from 1956 to 1960. He was deputy budget officer at the National Bureau of Standards from 1954 to 1956; head of the estimate and analysis section at the Navy Bureau of Ordnance from 1952 to 1954; and a budget and program analyst with the Navy Ordnance Test Station, Calif., from 1950 to 1952.

Foreign Nationals Assist in Air Research

NASA has a long history of welcoming people from many countries into aeronautical research programs in the United States. Visiting researchers often are experienced in aeronautics as a result of extensive training in their own countries, and a number of them elect to augment their studies at NASA's Langley Research Center.

The subsonic-transonic aerodynamics division at the Langley center presently has six researchers from India. All six men hold doctorate degrees. They are at the center through contracts and grants.

Dr. M. A. Ramaswamy of Bangalore, is doing research on wind tunnel volume wall effects. Ramaswamy arrived at Langley in June 1978 through the U.S. National Research Council. He holds a bachelor's degree in mechanical engineering from Bangalore University and a master's degree in aeronautics from the India Institute of Science. He joined the staff of the India National Aeronautics Laboratory in 1960. From 1967 to 1971 he worked on his doctorate degree at the California Technological Institute and then returned to the Indian laboratory.

Dr. Sundareswara Balakrishna of Bangalore, is working on the modeling of cryogenic tunnels. He is at Langley through Old Dominion University. Balakrishna received his bachelor's degree in electrical engineering and his doctorate degree in automation from the Indian Institute of Sciences. He worked for 18 years at the India National Aeronautics Laboratory on various aeronautical systems. Balakrishna's interests are in control systems, structural testing and aeronautical control problems.

Dr. D. M. Rao of Bangalore, is working on vortex flow concepts for improving transonic and supersonic aircraft. Previously he worked on advanced cargo concepts. Rao is working at Langley through ODU also. He received his bachelor's and master's degrees in general science from Allahabad University, India, and his doctorate degree in aeronautics from the University of London. He has worked for 15 years at the India National Aeronautics Laboratory.

Dr. Suresh H. Goradia, of Bombay, is working on boundary-layer development and multi-component airfoils. Before that he developed original theoretical and computer programs for viscous flows on clean wing and lift systems. Goradia received his bachelor's degree in mechanical engineering from Bombay University, his master's degree in mechanical engineering from the University of Michigan and his doctorate degree in mechanical engineering from Georgia Tech. From 1961 to 1964 he worked at Air Products and Chemical Inc., Allentown, Pa., in cryogenics and in 1964 he joined the staff at Lockheed-Georgia.

Dr. C. S. Reddy of Nellore, is working on numerical investigation of aerodynamic characteristics of wings with separated flows. Before coming to Langley he served as an assistant professor of mechanical engineering at ODU during the 1977–78 term. He received his bachelor's degree in mechanical engineering from the S.V. University in India, his master's degree in mechanical engineering at the University of Hawaii and his doctorate in thermal and fluid sciences from Clarkson College of Technology, Potsdam, N.Y. Reddy has worked as a design engineer for a power plant and taught mechanical engineering at an Indian university for about eight years. He came to the United States in 1972. He also served as a post-doctorate fellow for about eight months at Clarkson.

Dr. Sudhir C. Mehrotra of Kanpur, is working on jig shape predictions for models to go in the National Transonic Facility tunnel. He also has worked on the effects of aerolasticity in supersonic cruise aircraft research and transonic aircraft technology. His interests include aerodynamics and elasticity. Mehrotra received his bachelor's degree in aerospace engineering from the Indian Institute of Technology, Kanpur, and his master's degree and doctorate degree in aerospace engineering from the University of Kansas. He has worked at Langley since 1974

through the University of Kansas. Mehrotra is the representative of all West Indians living in the area.

Film Favorites

Three NASA films took top honors in their categories at the recent International Film and TV Festival of New York: "Flying Machines," produced by the office of public affairs motion picture production office, was awarded a Silver Medal (second place) in the transportation category.

"The Weather Watchers" received a gold medal (first place) in the environmental category. This film was produced through the public affairs office at Goddard Space Flight Center.

"19 Minutes to Earth" also received a first place gold medal in the classroom educational category. This film was produced through the educational services branch at headquarters.

"The House that NASA Built," produced by the motion picture production office, received a 1978 CINE Golden Eagle Award at a recent awards ceremony in Washington, D.C.

Contractor News

The Boeing Commercial Airplane Co., Seattle, Wash., has been awarded a $17-million, four-year NASA contract for the development and evaluation of selected advanced aerodynamics and active controls concepts for commercial transport aircraft. The cost will be shared, with the Government providing approximately $15 million and the contractor providing approximately $1.7 million. This contract, to be managed by the Langley center, represents the company's part of the second phase of energy efficient transport work, which began in early 1977 under two NASA contracts. The second phase concentrates on additional development and evaluation of promising concepts for improved energy efficiency and operational economy on subsonic, long-haul commercial transport aircraft.

The General Electric Co. at Edwards AFB, Calif., has received a contract renewal for aircraft engine maintenance, modification and repair at the Dryden center. The cost-plus-fixed-fee, one-year contract is estimated to cost $1.3 million. This is the second option awarded on the contract. The company will perform periodic engine inspections, incidental shop work and modifications to the engines or their associated propulsion components in the F–104, T–38, T–37, and and F–8 aircraft at Dryden.

Goodyear Aerospace of Akron, Ohio, has been chosen for negotiation of a Phase I contract for a "massively parallel processor." The term parallel means the use of more than 16,000 small processing elements operating simultaneously. One of the uses of this new computer arrangement could be for extracting information from images acquired by Earth observation spacecraft. The contract will be a Goddard center responsibility.

The Vought Corp., Dallas, Texas, has been awarded a $6.5-million modification to their contract to provide Scout launch vehicles to NASA, to be managed by the Langley center. Under the modification, Vought will provide 12 additional guidance systems for use on Phase 8 Scouts. This is the same type of system used on the launch vehicle since the Scout program began. Vought has been the Scout Project's prime contractor since 1959. The first Scout was launched on July 1, 1960, and was designed to place a payload into a circular Earth orbit. Today's Scout is designed to place a much larger payload in that orbit. The same corporation has been awarded a $1.4-millon NASA modification to their contract to provide Scout launch vehicles. Under this modification, Vought will provide 10 Castor II Scout rocket motors between now and April, 1980.

Life-giving Donations—Langley employees set a new record for Bloodmobile visits to the center this year when they donated 152 liters of blood. George G. Kerner, Jr. (left) has given a total of 9½ liters and Charles E. Edmiston has given 11.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office o NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicaed insallaion.

Inventor(s) and Employer	Title	Patent No.	Installation
Lubert J. Leger, JSC	Thermal insulation attaching means	4,124,732	JSC
Chester H. Wolowicz, DFRC	Free wing assembly for an aircraft	4,124,180	DFRC
Phillip E. Barnes, United Technologies Corp., Windsor Locks, Conn.	Cam-operated pitch change apparatus	4,124,330	LeRC

Launches for 1979

Name	Launch Date	Vehicle	Range	Mission Remarks
SCATHA	Jan. 25	Delta	ETR	DoD R&D. Spacecraft charging at high altitude. Reimbursable.
SAGE-A	Jan. 25	Scout	WFC	NASA applications satellite. Stratospheric aerosol and gas experiment.
NOAA-A	April	Atlas-F	WTR	NOAA weather satellite. Reimbursable.
Navy-20, C/U	April	Scout	WTR	DoD transit. Reimbursable.
FLTSATCOM-B	May	Atlas Centaur	ETR	DoD Navy communications satellite. Reimbursable.
UK-6	June	Scout	WFC	UK scientific satellite. Reimbursable.
Westar-C, C/U	July	Delta	ETR	Western Union communications satellite. Reimbursable.
Intelsat V-A	August	Atlas Centaur	ETR	Intelsat communications satellite. Reimbursable.
HEAO-C	September	Atlas Centaur	ETR	Third high energy astronomical observatory to study highly energetic radiation from space.
Space Shuttle	September	Space Shuttle	ETR	First manned orbital flight.
MAGSAT-A	September	Scout	WTR	NASA applications satellite to study magnetic field.
Navy-21	October	Scout	WTR	DoD transit satellite. Reimbursable.
SMM-A	October	Delta	ETR	NASA solar maximum mission satellite.
Intelsat V-B	November	Atlas Centaur	ETR	Intelsat communications satellite for Comsat. Reimbursable.
NOAA-B	December	Atlas-F	WTR	NOAA weather satellite. Reimbursable.
RCA-C	December	Delta	ETR	Domestic communications satellite. Reimbursable.

Congressional Visitor—Senator Russell B. Long toured NASA's Michoud Assembly Facility in New Orleans. He is seen chatting with Wilton "Happy" Walker (left), an inspector with the Martin Marietta Aerospace Co.

Langley the Site of ADP Meeting—A meeting of the NASA Intercenter Committee on Automatic Data Processing was held at Langley center in October. Photo shows Ken Webster, recently returned director of the headquarters ADP management office, receiving a plaque from the committee in appreciation of his years of service to the agency. The committee is composed of senior ADP management personnel from each of the NASA installations and serves as a mechanism for coordinating agency-wide matters concerning ADP management practices and policy.

Sky Writing—Goddard's deputy director Ed Smylie (left) and Jackson Bain, host of the Washington TV show "Panorama" (right) listen intently as astronaut Don Lind describes a Space Shuttle mission. The 20-minute discussion of the Shuttle flooded the studio with calls and questions from interested viewers.

NASA-State Department Aid Team View First Bangladesh Weather Images—During tests at P and P Industries, College Park, Md., fabricators of a newly designed weather data-receiving system for Bangladesh, project manager Charles "Chuck" Vermillion of the Goddard center interprets weather data imagery for members of the State Department's AID. Next to Vermillion is Geff Clark and William Beddington (space programs). State Department director of the Office of Foreign Disaster Ms. Anne Martindell is second from right, standing beside colleague Paul Krumpe. The new automatic picture transmission system developed for the Bangladesh National Cyclone Warning System is the first of its kind having the capability of receiving transmissions from weather spacecraft of three different nations. Located on the capital city of Dacca airport complex, the six-meter antenna system acquires weather data from the Japanese Geosynchronous Meteorological Satellite, the Russian Meteor and recently launched American Tiros operational weather spacecraft. Bangladesh President Zia Rahman requested the installation as an aid to solving the many weather-caused problems that plague the new nation.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Fog-free Goggles

The goggles shown in accompanying photograph are electrically heated to provide fog-free sight in activities such as skiing that demand total vision. The goggles incorporate technology similar to that used by Apollo astronauts in helmet visors, to whom unimpaired vision was vital.

Defogging is accomplished by applying heat to prevent moisture condensation. Electric heat is supplied by a small battery built into the headband of the goggles. Heat is spread across the lenses by means of an invisible coating of electrically conductive metallic film.

The goggles were introduced to the market about a year ago, based on a design by Sierracin Corp. of Sylmar, Calif., specialists in the field of heated transparent materials. The company produces heated windshields for military planes and for such civil aircraft as the Boeing 747, McDonnell Douglas DC–10 and the Lockheed L–1011 TriStar.

The ski goggle lenses are manufactured at Sierracin's Sylmar Division and the product is marketed through Smith Goggle Company, Sun Valley, Idaho.*

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

For the benefit of all . . .

NASA
National Aeronautics and Space Administration

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